CHAPTER 1

The Geopolitics of Higher Education

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INTRODUCTION

Today, Higher Education Institutions are not only globalized but also globalizing entities. This evolution has gradually formed over the last three decades, changing profoundly the world landscape of academic institutions, which has become a competitive market.

Academic globalization most often refers to the increasing openness of universities to exchanges, student and researcher mobility, the multiplication of strategic partnerships and the harmonization of curricula and degrees. This globalizing dynamic takes place in very diverse contexts from economic, social and historical points of view. What common characteristics exist today between the major classical research universities in the Top 100 of the Shanghai ranking and a university located in a developing country that has to manage large numbers of students and where research activities are often non-existent? In addition, the gap between those different universities tends to widen since globalization increases the dynamics of inequality and reinforces the logic of competition.

One important factor in university globalization is the access of an ever-increasing proportion of the population to higher education. Over the past three decades, the number of students worldwide has almost doubled every 10 years, from 50 million in 1990 to more than 215 million today, probably reaching 380 million in 2030 (Vetterli & Escher, this volume). Remarkably, the centre of gravity of the student population has shifted. Since 2003, there are more students in so-called emerging and developing countries than in

OECD countries. Most of this changeover was due to China and India, which now have more than 50 million students. China, in particular, has put in place a strategy to encourage its best students to train at the best universities in the world and then offer them very attractive jobs and high salaries to encourage them to return home. Therefore, it is no coincidence that it is precisely China that has set up the first international ranking to identify the universities to which its students should be sent.

Actually, university rankings play a crucial role and are an important indicator of the power of universities to attract the best students and the most productive researchers. They are also indicators for the economic health of countries, not only because they point out the capacity of nations to invest into higher education, but also because the ratio of public expenditures on education to the GDP is a factor of economic success. As part of what is sometimes called smart power, knowledge, and more precisely higher education, appears to be both an index of influence and a power factor. From this point of view, the international rankings that have abounded over the past 20 years have played a major role in this reconfiguration of the university landscape on a global scale. We will therefore first ask ourselves why these rankings appeared and how they were established.

GOING GLOBAL: WHY?

A number of trends are responsible for driving change across higher education and university-based research over recent decades. There are two broad dimensions: the changing social contract between higher education and society, and the geo-politics of knowledge in a globally competitive world. Globalization has partially transformed higher education and the increasing reliance on knowledge for economic competitiveness has obliged the state to remain involved in higher education, even as it purports to withdraw from other spheres through privatization. While science has always operated in a competitive environment, the emergence and increasingly persuasive role of global rankings has made the tension between national and global ever more apparent.

The rise of neo-liberalism and corresponding adoption of principles of new public management are credited with changing the relationship between higher education and the state, and between the academy and the state. This led to more autonomy focused on performance-based funding or performance agreements.

The birth of international rankings was marked by the advent of Shanghai Jiao Tong Academic Ranking of World Universities in 2003. But their true origins lie in the growing tension between the role of knowledge for global

competitiveness and, correspondingly, the national social contract with higher education and science. International rankings are a product of an increasingly globalized economy and an internationalized higher education landscape, which has become a competitive market. These rankings affirm that in a globalized world, with heightened levels of capital and talent mobility, national pre-eminence is no longer sufficient. Despite considerable scrutiny and criticism over the years, rankings have persisted in informing and influencing educational policy, institutional funding, academic behaviour and stakeholder opinion.

The emergence of a global knowledge society poses new challenges for universities, which are places of creation, innovation and knowledge transmission. The United States and Japan, as well as India and China, have understood this and have massively increased support for university scientific research in recent years. Switzerland, whose position is still enviable, must meet these challenges in a context that could become more difficult if it were to isolate itself from the European Union. More than ever, its socio-economic development depends largely on its ability to train the many young people sorely needed by our country, lacking any other natural wealth, to ensure lifelong learning and to foster an evolution of society that enables it to respond to the changes it must face. The University, through its ability to develop world-class research centres, is an absolutely necessary instrument for this socio-economic development.

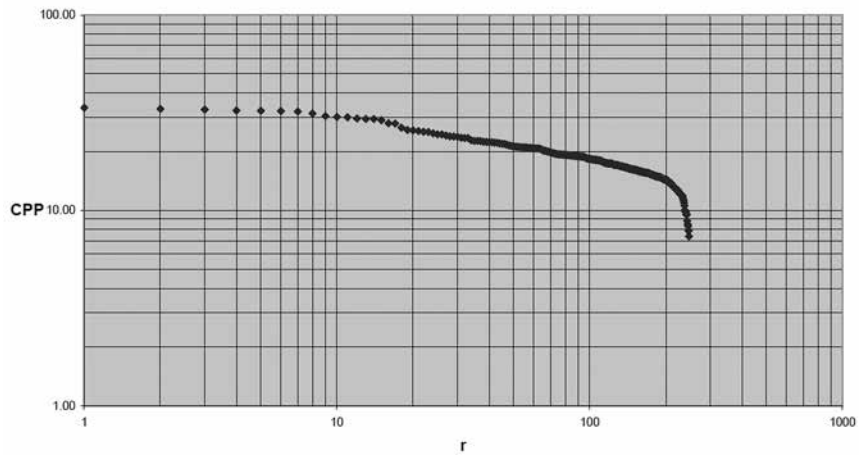
But to maintain its position in an increasingly competitive international environment, universities must cultivate their excellence. Not for themselves, but to make their essential contribution to the region in the area where they are located. Even if the very concept of excellence, and the criteria for measuring it, are often criticized, they nevertheless make it easy to compare the different universities around the world and thus constitute, for young people, an often important element in their choice of place of study. They also send a strong signal to employers who make a first selection based on their candidates' applications; and undeniably influence the ability of academic institutions to raise donor funds.

Typically, the Shanghai ranking exclusively measures the quality of a university through cutting-edge research, whether fundamental or applied. Although it is regrettable that there are no criteria related to teaching or other aspects of university excellence, this ranking has the advantage of being based on objective data collected by the rating agency and not by the universities themselves. However, the main criticism of this ranking remains that it tends to ignore disciplines that do not award Nobel prizes or that do not have access to scientific journals such as *Nature* or *Science*.

More than the precise rank obtained in rankings, universities must maintain their position among the 200 best universities in the world. It is at this

level that the competition to attract talent from all over the world is making it possible to nurture the training and research of an academic institution. Otherwise, a university can no longer play its role as a driving force for economic and social innovation, which is a pillar of the competitiveness of its region. This need is clear from the analysis presented in Figure 1, which shows that the number of citations per published article in the life sciences field is a decreasing function of the rank obtained by a university (Van Raan, 2005). Interestingly, Figure 1 shows that beyond the 200th rank, the number of citations drops sharply, demonstrating the loss of impact that these articles have on the development of the life sciences.

Figure 1 – Correlation between impact of top universities in the life and biomedical sciences (CPP) and ranking position (r)



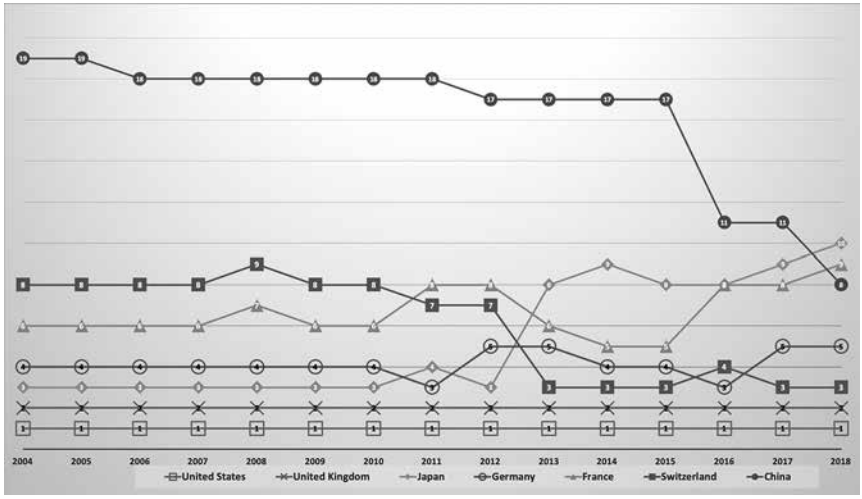
The quality of training is closely linked to the quality of research. This requires attracting the best talents. The excellence of researchers is a necessary condition for academic institutions to remain at the level of the best research centres throughout the world. It is from competition between the elite of researchers that the most spectacular scientific advances and innovations necessary for the economic development are born. It is also through their collaboration and the shared use of advanced, complex and costly infrastructure that science is advancing.

China in particular has adopted a highly geopolitical strategy to bring its best universities to the top of the Shanghai ranking, a strategy that was quite successful considering Figure 2 which shows the ranking by countries according to the number of national universities belonging to the top 100 best institutions. The Chinese student diaspora has grown steadily in recent years. According to the Chinese Ministry of Education, in 2010 1.27 million

Chinese students had gone abroad to study. In comparison, in 1990 only 7,647 had been sent abroad to study (China Education Yearbook Editorial Board, 1991). At the same time, the Chinese government is encouraging these students to return to China and attract many foreign students to train them. This scientific community has an influence on investment decisions in Research and Development, whose weight in relation to GDP has more than tripled over the last three decades, from 0.56% in 1996 to more than 2% in 2015, to reach the objective of 2.5% in 2020, the level reached by the United States.

In this perspective, international rankings play an important role on the prestige and attractiveness of global universities. This is why the European Commission has decided to create its own index, the U-Multirank, whose objective, more or less admitted, is to promote European universities. The spread of Shanghai's ranking throughout the world, both in the media and in the political sphere, has made university rankings a powerful tool that goes far beyond the academic field.

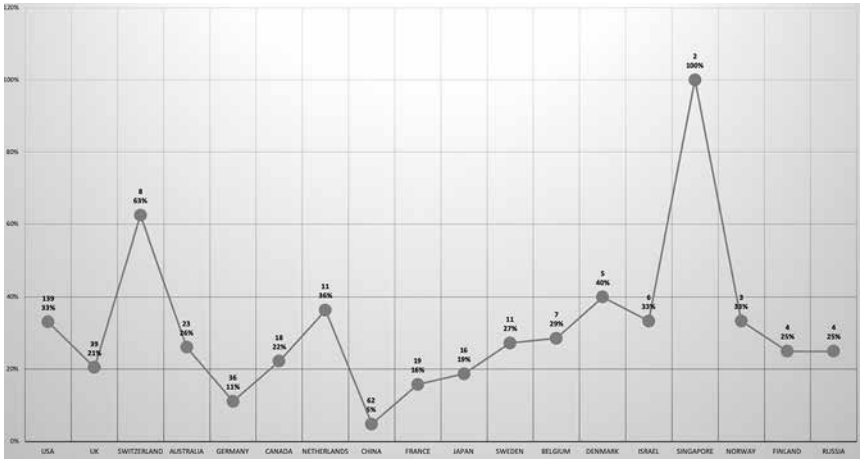
Figure 2 – Evolution of rankings for some countries
(Academic Ranking of World Universities-Shanghai Ranking Consultancy)



If China's strategy was successful in terms of this policy to bring its best institutions among the top 100 universities, Figure 3 however shows that there is wide disparity within the Chinese academic system. Only 5% of the 62 Chinese universities ranked in the top 500 in the world belong to the top 100, a ratio that stands at 100% in Singapore and 63% in Switzerland. This result shows that the majority of students in the latter two countries benefit from a quality education.

As illustrated by Figure 3, one of the criticisms frequently made of international university rankings is that they contribute to increasing inequalities between mass and research universities but also, and even among universities in developed countries, between academic institutions according to the total amount of their budget or the amount of their budget per registered student. From this point of view, it is interesting to consider the revised Shanghai ranking by weighting the results by the size of the budget, first, and then by the size of the budget per student. Tables 1 and 2 in the appendix highlight the upheavals brought about by these new approaches. They show the more or less efficient use made by universities of the resources allocated to them, putting all institutions on an equal footing regardless of the size of their budget — and it should be noted that the usual numbers 1 and 2 are no longer even in the top 50. (Olivier Berné, CNRS and Université de Toulouse, https://nouvellesdesetoilesblog.wordpress.com/2018/08/17/le-classement-de-toulouse-des-universites/).

Figure 3 – Ratio between the number of universities in the Top 100 and number of universities in the Top 500 for all countries that have at least one university in the Top 100 (Academic Ranking of World Universities-Shanghai Ranking Consultancy)



GOING GLOBAL: HOW?

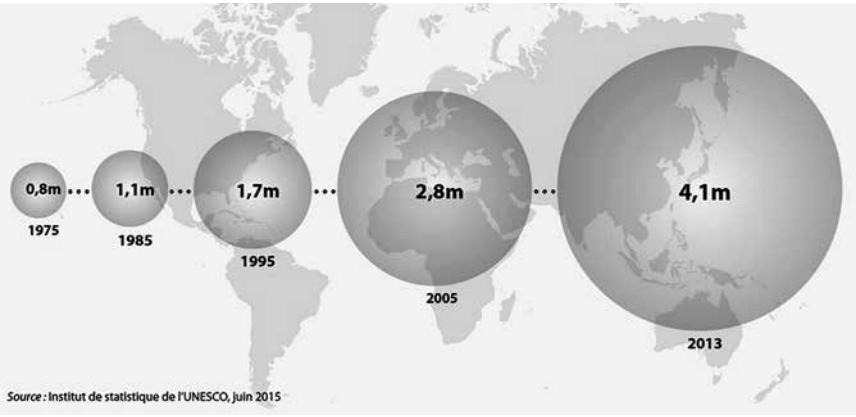
Some facts about the internationalization of universities

Academic mobility (students and faculty) is a tradition that dates back to the creation of universities and it is certainly the most frequently considered example for the internationalization of universities. Nevertheless, since the

1990s other elements have also taken place in this context, such as the internationalization of curricular and the development of university partnerships.

As can be seen in Figure 4, student mobility has intensified with the globalization of the higher education sector. The goal of the Bologna Process was precisely to create a European Higher Education Area, with comparable institutions in terms of standards and quality of higher education qualifications to facilitate academic mobility.

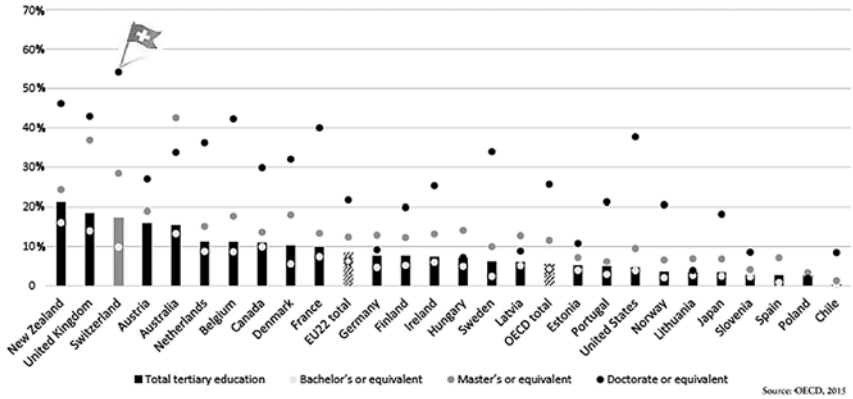
Figure 4 – Growth of international students worldwide 1975-2013



Indexes and metrics are a valid and necessary starting point for the analysis of globalization and student mobility. However, in the end, it is all about people. When individuals decide to pursue studies in a foreign country, they do so in the hope of being exposed to an experience that will nurture their lives and help them build a better future for themselves and their families. Cultural values are rapidly changing and the younger generations are realizing that international mobility dramatically increases the number of opportunities available for individual advancement.

International mobility is also organized in a competitive mode where universities compete for the best professors and students, which has an impact on the geopolitical map of higher education. Thus, it is not surprising that leaders of technological companies such as Bill Gates consider that the only way to solve the US "critical shortage of scientific talent" is to open up the visa system to special categories of immigrant workers. This competition to attract talents is illustrated by Figure 5, especially at the level of PhD Students for countries like Switzerland lacking highly qualified people to sustain their economic development.

Figure 5 – Percentage of foreign students at different level of the curriculum



To the above arguments regarding competition for talents, it could be added that higher education is more and more considered an important diplomatic asset contributing to a reduction of friction between countries and cultures. It is not surprising to see new organizational initiatives linking foreign policy with international student mobility and academic cooperation, e.g. the creation of the Bureau of Educational and Cultural Affairs at the US Department of State or locating outposts of Campus France in French embassies around the world.

Interestingly, students from developing countries present a higher willingness to move between national borders than those from developed nations. This "cultural melting pot" poses a challenge for host countries. Although at first glance it may appear the students coming from developing countries are being unilaterally exposed in the cultural waters of industrialized nations, it is also true that the incoming cultures are transforming the receiving countries' behaviours. Well-established institutions attracting an increasing number of international students are already facing a dilemma of balancing their own "traditions" — the ones that took them to the leading position they occupy today — with the need of internalizing the cultural baggage brought in by international students. International mobility may be accompanied by turmoil, but it is a challenge that any country and any university wishing to excel in the higher education arena cannot avoid.

Internationalization has also reformed curricula with the aim of injecting an international element into the content and delivery of programmes. The most prominent (though possibly not the most frequent) form of curricular internationalization is the delivery of a program in a language other than the one of the country where this programme is offered. In the vast majority of all cases in Europe, this language is English. English-medium provision

in Europe has seen a strong growth in the last five years, even though it still constitutes only a fraction of all provision in European higher education. What makes this form of education international is, first and foremost, the language of delivery, and — second, and only related — the (usually) international composition of the student body. In addition to this, they are international curricula, which are jointly delivered by two or more higher education institutions in at least two countries. More recently, new forms of internationalization appear consisting in a variety of manifestations, from branch or off-shore campuses to delivery abroad of programs with the help of a (licensed) foreign tertiary institution, and various forms of distance (usually online) education offerings, to name only some. The common feature of all these is a particular form of mobility, in which it is not the student that moves across a country border, but the educational offering.

Universities are also faced with the necessity to build international partnerships and establish mobility pathways which carry both knowledge and social impact, which contribute to social growth as well as institutional growth. It should be noted that there is also growing internationalization in the context of "quality", evidenced, not in the least, by the attention accorded to international rankings. In 2018, the International Association of Universities (IAU) conducted its fifth global survey and it appears that the two most important benefit of internationalization are "enhanced international cooperation and capacity building" and "improved quality of teaching and learning".

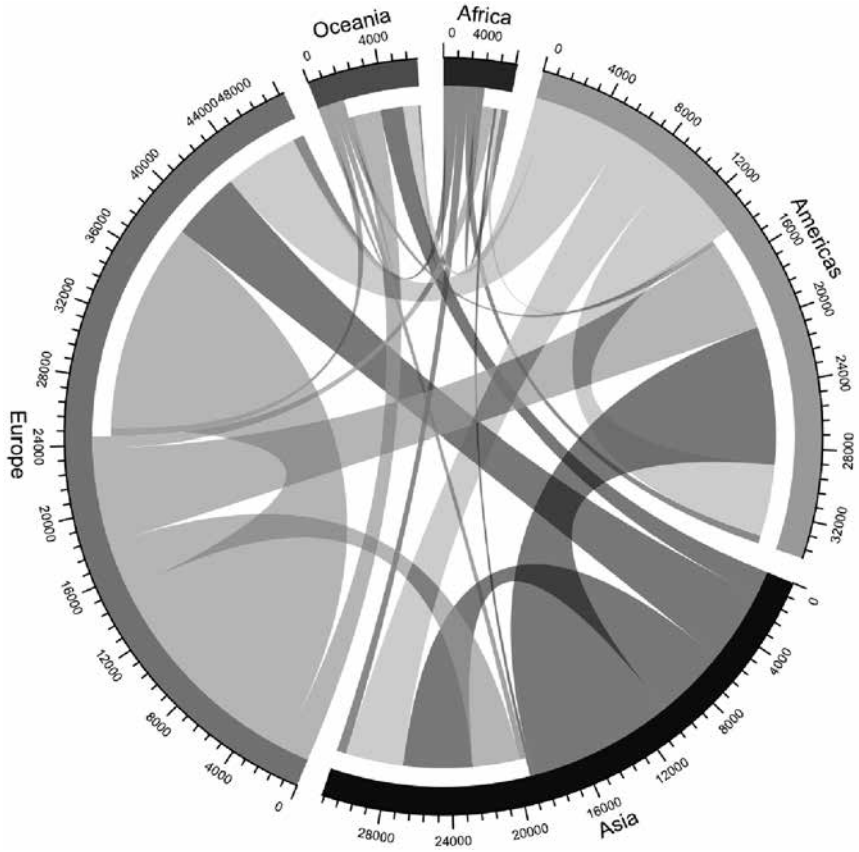
The key challenge facing Higher Education Institutions is not only to monitor and track partnerships beyond the agreed memoranda of understanding, but to build and to sustain mobility and internationalization, through the resourcing of intelligent solutions, trend analyses and performance data which can be leveraged into institutional strategy for growth, excellence and impact in an ever-changing world. It is not a surprise, then, that Asian countries — particularly China and India — are the main source of internationally mobile students, while Western countries with solid higher education systems lead the way in terms of inbound flows.

If, for the time being, there has been uncontested dominance of North American and European higher education, together with Japan, it is only a matter of time before this lead starts to diminish. The enormous, long-term growth-potential, combined with a favourable political climate for economic development, makes it inevitable that by the middle of this century higher education in other regions will catch up in every way that matters in their respective economic progresses. European universities, particularly those functioning in systems with generous public support, have a mixed attitude in accepting the new paradigm of global academic competition and advocate the status quo combined with an increase in public funding.

Researchers' mobility

If we look now at researchers' mobility, it can be observed that Europe is high in mobility with much intra-region movement, while Asia has more outbound movement, mostly to Americas, followed by Europe, and then Oceania. The Americas have more inbound movement, from Asia, Europe and same region.

Figure 6 – Mobility in and out of Researchers



Figures 7 and 8 represent the ratio between researchers migrating out of a given country in comparison with researchers moving in. Without any surprise, beside India, China has the second-highest ratio, losing five times more talents than gaining them. This is fully in line with the Chinese strategy to build a higher education system based on researchers educated abroad. In terms of attracting researchers, Qatar and Saudi Arabia are getting the most influx compared to very little outbound movement. Singapore and HK in Asia, as well as Switzerland, are also attracting 2–3 times more researchers than losing them.

Figure 7 – Highest Outbound/Inbound ratio in research migration

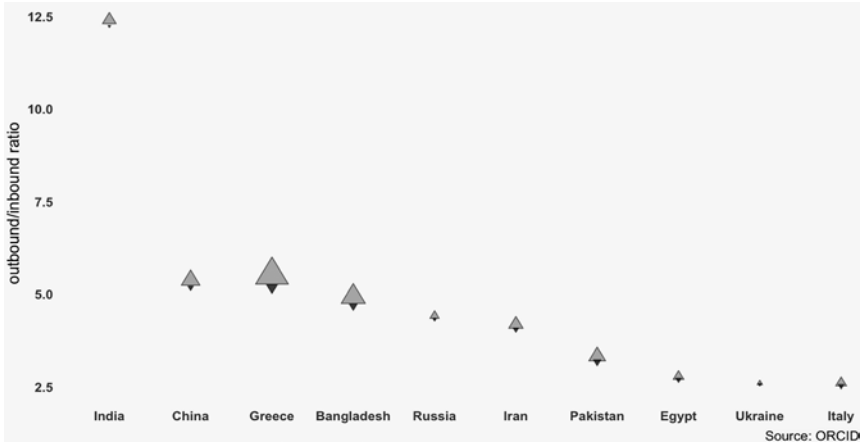
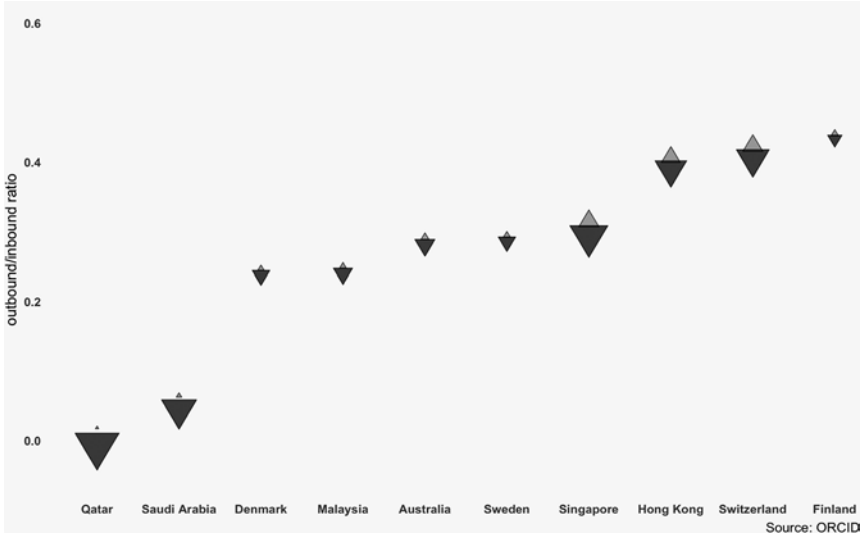


Figure 8 – Lowest outbound/inbound ratio in researcher migration



THE GEOPOLITICS OF RESEARCH AND THE EFFICIENCY OF PUBLIC POLICIES

Publications as a key element of rankings

Nowadays, the big funding for research is allocated only to the best projects. Good is not sufficient. For this reason, we can talk of a new quality regime: "moving from good to excellence" in higher education and research policy. This new

quality regime combined with searching for excellence also raises one of the most challenging problems related to institutional configuration of European (continental foremost) higher education. Such a regime may question the system-wide validity of the so-called Humboldtian model of the university which has been the dominating conceptual and organisational framework for higher education in Europe for almost two centuries. This model puts "research" at the heart of the traditional university and is naturally linked to teaching, thus assuring a mutually reinforcing mechanism for the free circulation of knowledge between research and teaching. We do not consider that the Humboldtian model is altogether obsolete, but it does only reflect a certain type of higher education institution, which is often referred to as the "research-intensive" university.

Can we afford for all institutions to be "research-intensive"? No less important for our analysis is that research has become a highly globally competitive activity, which requires enormous investments in personnel, infrastructure and equipment. Therefore, when trying to adapt themselves to "the global battle for intelligence", countries are introducing a preferential system for supporting research excellence, recognizing that only through a competitive approach and a steady level of appropriate funding are they going to be better positioned for meeting the future challenges of higher education and research. In this context, publications, as the ultimate output of research, play a crucial role for in terms of geopolitics of higher education.

During the last 20 years, the evolution of the number of papers published by Chinese universities is impressive. In a recent article, Xie and Freeman (2019) measure countries' contribution to the world scientific literature according to the authors' addresses. Applying this methodology to the Scopus database of international scientific journals, the authors found out that China's share increased from 4% of all articles in 2000 to 18.6% in 2016, exceeding the US total. However, this is still an underestimate as it does not consider articles written by Chinese researchers at non-Chinese addresses and articles in Chinese language journals that are not included in the Scopus database. When these elements are considered, China's contribution accounts for 36% of the world's scientific publications. China's move to the forefront of scientific inquiry makes it a key driver of the direction of scientific and technological progress and of the knowledge-based economies of the foreseeable future.

It is evident that as universities and other higher education institutions became one of the founding blocks for a modern "knowledge-dependent economy", their roles have increased, but then so has the public interest in their functioning. Institutions of higher education are big providers of services, large employers, and receivers of significant public funds. In other words, on the one hand, higher education has become too important to be left to higher education institutions and academics alone, but, on the other hand, it must have enough institutional autonomy and respect of academic

freedom in order to be able to respond to such challenges. Identifying appropriate policies is thus a global challenge.

Efficiency of public policies

While international rankings respond to a public policy concern, also linked to New Public Management tools, which has had a profound impact on the culture of evaluation, they have also helped to reconfigure geopolitics in terms of training and research. The question that needs to be asked, however, is whether the countries that spend the most on education are also the ones that get the most flattering rankings. In other words, it is about the efficiency of public spending.

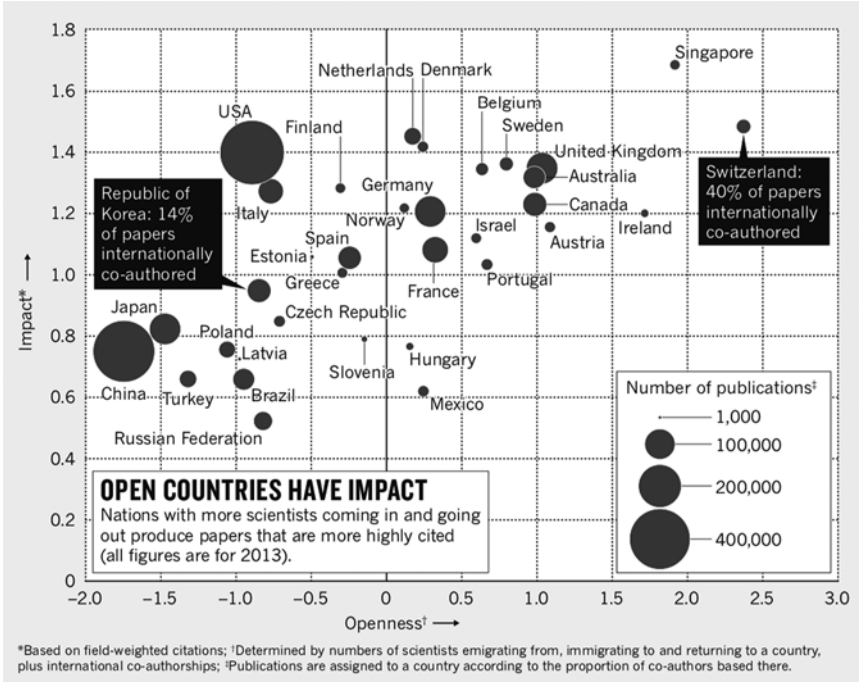
In a recent paper published by *Nature* (Wagner & Jonkers, 2018), the authors analyse whether there is a relation between publication and citation for 36 nations, along with government expenditures on science. They found that, although government spending on research and development (R&D) does correlate with the number of publications produced, it does not correlate with scientific impact, at least as assessed by citations.

In terms of papers published, the United States and China dominate as can be seen in Figure 9 by the size of the bullet point associated to each country. For papers written with international co-authors from more than one country, the United States still leads, followed by the United Kingdom, China, Germany, France and Canada. However, when the authors considered this number in percentage to the total number of articles published by each country, Switzerland (42%) appears as the most connected country, followed by Belgium (38%), Singapore (37%), Austria (36%) and Denmark, the Netherlands and Sweden (all 34%). In terms of impact for international papers, Singapore tops the list, followed by the United States and then Sweden, Belgium, Switzerland and the Netherlands.

To understand the factors that could explain the impact factor of publications, Wagner & Jonkers used in addition to international collaboration, scientific mobility by taking into account new researchers coming in, as well as returnees and emigrating researchers. These variables were finally used to create an index of openness. Using this new variable, the authors show that countries that are highly "open" produce high-impact research. The correlation between openness and citation impact was tight ($R^2 = 0.7$ according to a regression analysis) regardless of R&D spending or numbers of articles published. Thus, it appears that Public R&D funding is tied to publication output. The more money spent, the more articles produced. But it has been found that there is only a weak correlation between spending and impact. In other words, more government funds spent does not necessarily result in more citations. Countries with low openness and low impact are located in the lower-left quadrant of Figure 9. Against expectations, South Korea

(which spends a higher percentage of its GDP on R&D than almost every country, including the United States) and China belong to this category.

Figure 9 – Openness and impact of research. Source: Nature, vol. 550 (32 - 33), 5 October 2017



Many of the countries whose research has high impact, and whose policies encourage international engagement, are from Europe. The EU has established the European Research Area (ERA) and its governments have been implementing measures to strengthen domestic research systems while also promoting both international collaboration and mobility. Analysis of citation strength shows that many European countries have greatly enhanced their impact compared with the United States. As a bloc, the EU now outperforms the United States. Both far exceed China in impact, although China's share of high-impact papers is growing rapidly.

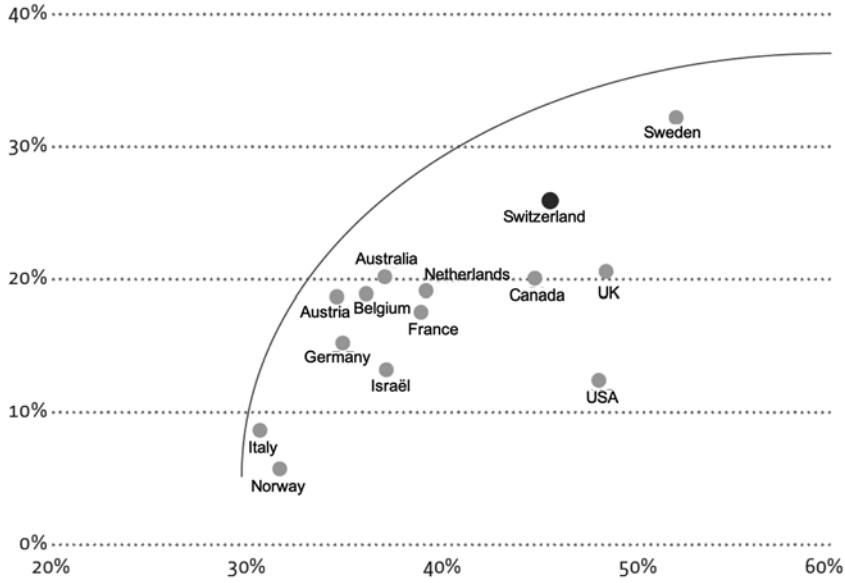
This analysis suggests that national funding programs should whenever possible move away from policies that fund only national researchers. In the longer term, countries could benefit more by funding the best science, wherever it is, and ensuring that domestically based scientists are linked with it. Restricting the movement of researchers could be counterproductive.

In terms of training, the effectiveness of public spending on tertiary education, it may be interesting to examine the relationship between the

percentage of students enrolled in high quality universities and public spending on tertiary education. Looking at Figure 10, it appears that there seems to be a relationship between the two variables that can be illustrated by an efficiency "frontier" that relates input (public expenditure) to output measured in this case through the share of students enrolled in a university ranked among the top 200 in the Shanghai ranking.

This figure shows that the United States has a relatively inefficient tertiary education system with a low proportion of students enrolled in a very good university compared to the public investment made, probably because almost all young Americans are enrolled in tertiary education. On the other hand, Italy, which has few universities ranked in the top 200, nevertheless obtains a very satisfactory result if we link it to public investment. Switzerland is close to the efficiency frontier, but could improve its performance by possibly accepting a greater concentration of its strengths among the best universities. It could be seen as the price to pay for an educational policy that has other objectives such as regional policy or linguistic diversity.

Figure 10 – Efficiency of public spending on education (CSRE, 2019, p. 194) % of students in one of the top 200 universities (Shanghai Ranking 2016); Education expenditure per person in tertiary education compared to GDP per capita, 2014. Note: The curve in the graph represents the hypothetical efficiency limit, i.e. the maximum rate of students in one of the best universities that the expenditure considered achieves.



Source: Data: OECD, Eurostat, internet research carried out by Centre suisse de coordination pour la recherche en éducation (CSRE). Calculations: CSRE.

CONCLUSIONS

With globalization, the field of higher education has become a competitive global market where universities must attract the best talent to be recognized as the best. In this context, international rankings, which have emerged from this globalization to give a measure of university excellence, greatly influence educational policies, institutional funding and stakeholders. The funding of institutions is more and more linked to rankings and scientific production, but not really to the impact of it on society, nor do they reflect the effectiveness of a particular education system. Over the past 20 years, we have seen a change in the geopolitics of higher education, with the rise of certain regions, such as China, alongside the traditional European and North American institutions. Today, with ever-increasing mobility of talent, the upheavals we are witnessing will continue in the future and continue to modify the geopolitics of higher education. This is all the more so since, as we have been able to highlight, internationalization contributes to significantly improving the effectiveness of public policies in the field of higher education.

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Table 1: Shanghai ranking weighted by the overall budget of universities (extract 50/100)

Rank	Intitution	Country	Score in Shanghai	Budget (M$)	Normalized score	Rank In Shanghai
1	Ecole Normale Superieure - Paris		2,86E+01	160	0,17875	69
2	University of Paris-Sud (Paris 11)		3,50E+01	336	0,104166667	41
3	Rockefeller University		3,66E+01	370	0,098918919	36
4	California Institute of Technology		5,73E+01	641	0,089391576	9
5	Moscow State University		2,66E+01	350	0,076	93
6	Pierre and Marie Curie University - Paris 6		3,55E+01	542	0,065498155	40
7	Technion-Israel Institute of Technology		2,66E+01	411	0,064720195	93
8	Leiden University		2,70E+01	467	0,057815846	88
9	Ghent University		2,86E+01	504	0,056746032	69
10	Erasmus University Rotterdam		2,84E+01	588	0,04829932	73
11	Stockholm University		2,82E+01	590	0,04779661	74
12	University of Oxford		6,01E+01	1336	0,04498503	7
13	McGill University		2,89E+01	646	0,044736842	67
14	Karolinska Institute		3,33E+01	760	0,043815789	44
15	University of Cambridge		7,09E+01	1643	0,043152769	3
16	Rice University		2,82E+01	680	0,041470588	74
17	University of Geneva		3,10E+01	779	0,039794608	60
18	The University of Western Australia		2,68E+01	677	0,039586411	91
19	University of California, Santa Cruz		2,60E+01	662	0,039274924	98
20	University of Washington		5,03E+01	1300	0,038692308	13
21	McMaster University		2,90E+01	752	0,03856383	66
22	Mayo Medical School		2,85E+01	750	0,038	71
23	Uppsala University		2,98E+01	800	0,03725	63
24	University of Helsinki		3,15E+01	860	0,036627907	56
25	Cardiff University		2,59E+01	724	0,035773481	99
26	University of Oslo		2,99E+01	840	0,035595238	62
27	University of Bristol		3,01E+01	869	0,034637514	61
28	University of Basel		2,63E+01	762	0,034514436	95
29	University of California, Santa Barbara		3,32E+01	1000	0,0332	45
30	Utrecht University		3,30E+01	996	0,03313253	47
31	Heidelberg University		3,48E+01	1057	0,032923368	42
32	Princeton University		6,11E+01	1926	0,03172378	6
33	University of Groningen		3,11E+01	983	0,031637843	59
34	King's College London		3,31E+01	1073	0,030848089	46
35	The Australian National University		2,61E+01	855	0,030526316	97
36	Imperial College London		4,09E+01	1381	0,02961622	27
37	The University of Edinburgh		3,70E+01	1295	0,028571429	32
38	Nagoya University		2,72E+01	1009	0,026957384	84
39	University of Copenhagen		3,85E+01	1435	0,026829268	30
40	The University of Manchester		3,61E+01	1388	0,026008646	38
41	KU Leuven		2,69E+01	1051	0,025594672	90
42	University College London		4,71E+01	1846	0,025514626	16
43	University of California, Los Angeles		5,25E+01	2063	0,025448376	12
44	Kyoto University		3,67E+01	1450	0,025310345	35
45	Georgia Institute of Technology		2,71E+01	1071	0,025303455	85
46	Vanderbilt University		3,20E+01	1274	0,025117739	52
47	Swiss Federal Institute of Technology Zurich		4,41E+01	1784	0,024719731	19
48	Carnegie Mellon University		2,77E+01	1128	0,024556738	80
49	University of California, Berkeley		6,91E+01	2819	0,024512238	5
50	University of Toronto		4,16E+01	1755	0,023703704	23

Table 2: Shanghai ranking weighted by the budget per student (extract 50/100)

	Univ	Score in Shanghai	N students	Budget (M$)	Budget / student	Normalized score	Rank in Shanghai
1	University of Paris-Sud (Paris 11)	3,50E+01	31400	336	10700,63694	0,003270833	41
2	Moscow State University	2,66E+01	40000	350	8750	0,00304	93
3	Ghent University	2,86E+01	41000	504	12292,68293	0,002326587	69
4	University of Toronto	4,16E+01	88766	1755	19771,08352	0,002104083	23
5	Pierre and Marie Curie University - Paris 6	3,55E+01	31000	542	17483,87097	0,002030443	40
6	University of Washington	5,03E+01	46165	1300	28159,86137	0,00178623	13
7	Leiden University	2,70E+01	28130	467	16601,49307	0,00162636	88
8	Stockholm University	2,82E+01	34000	590	17352,94118	0,001625085	74
9	McGill University	2,89E+01	35710	646	18090,17082	0,001597553	67
10	Uppsala University	2,98E+01	42559	800	18797,43415	0,001585323	63
11	KU Leuven	2,69E+01	55484	1051	18942,39781	0,001420095	90
12	Erasmus University Rotterdam	2,84E+01	28000	588	21000	0,001352381	73
13	University of Helsinki	3,15E+01	36500	860	23561,64384	0,001336919	56
14	Monash University	2,79E+01	73807	1555	21068,46234	0,001324254	78
15	University of British Columbia	3,77E+01	61113	1755	28717,29419	0,001312798	31
16	McMaster University	2,90E+01	31265	752	24052,45482	0,001205698	66
17	The University of Queensland	3,16E+01	52329	1400	26753,80764	0,00118114	55
18	The University of Edinburgh	3,70E+01	39669	1295	32645,13852	0,0011334	32
19	Cardiff University	2,59E+01	31597	724	22913,56774	0,001130335	99
20	University of California, Los Angeles	5,25E+01	43301	2063	47643,2415	0,00110194	12
21	The University of Melbourne	3,59E+01	48000	1600	33333,33333	0,001077	39
22	University College London	4,71E+01	41539	1846	44440,16466	0,001059852	16
23	University of Oxford	6,01E+01	23195	1336	57598,62039	0,001043428	7
24	University of Copenhagen	3,85E+01	38615	1435	37161,72472	0,001036012	30
25	The University of Manchester	3,61E+01	39700	1388	34962,21662	0,001032543	38
26	University of California, Berkeley	6,91E+01	41900	2819	67279,23628	0,001027063	5
27	University of Oslo	2,99E+01	28007	840	29992,50187	0,000996916	62
28	Utrecht University	3,30E+01	30000	996	33200	0,000993976	47
29	Heidelberg University	3,48E+01	29689	1057	35602,41167	0,000977462	42
30	The University of Western Australia	2,68E+01	24327	677	27829,16101	0,000963019	91
31	University of Groningen	3,11E+01	30000	983	32766,66667	0,000949135	59
32	University of Sydney	2,75E+01	56700	1646	29029,98236	0,000947296	83
33	Technion-Israel Institute of Technology	2,66E+01	14538	411	28270,73875	0,000940902	93
34	King's College London	3,31E+01	29600	1073	36250	0,000913103	46
35	University of Bristol	3,01E+01	25024	869	34726,6624	0,000866769	61
36	University of Cambridge	7,09E+01	19660	1643	83570,70193	0,000848383	3
37	Technical University Munich	3,27E+01	40841	1721	42139,02696	0,000776003	50
38	University of Munich	3,14E+01	51420	2090	40645,66317	0,00077253	57
39	Georgia Institute of Technology	2,71E+01	29369	1071	36467,02305	0,000743137	85
40	The Australian National University	2,61E+01	23761	855	35983,33403	0,000725336	97
41	University of California, Santa Barbara	3,32E+01	21574	1000	46352,09048	0,000716257	45
42	New York University	3,86E+01	59000	3273	55474,57627	0,000695814	29
43	University of Geneva	3,10E+01	16935	779	45999,40951	0,000673922	60
44	University of California, Santa Cruz	2,60E+01	16328	662	40543,85105	0,000641281	98
45	The University of Texas at Austin	3,25E+01	51331	2658	51781,57449	0,000627636	51
46	University of Goettingen	2,63E+01	31500	1346	42730,15873	0,00061549	95
47	University of Wisconsin - Madison	3,97E+01	43820	3000	68461,88955	0,000579885	28
48	Kyoto University	3,67E+01	22657	1450	63997,88145	0,000573456	35
49	University of Zurich	3,13E+01	25542	1400	54811,68272	0,000571046	58
50	Purdue University - West Lafayette	2,80E+01	41573	2094	50369,23003	0,000555895	77